jc921 U.S. PTO 10/13/00

10/16/00

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DOCKET NUMBER: **RR11462**
October 13, 2000

jc921 U.S. PTO
09/687486
10/13/00

Transmitted herewith for filing is the Patent Application of:

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For: **MOBILE IP EXTENSIONS RATIONALIZATION (MIER)**

Enclosed are:

X Patent Specification and Declaration

X 4 sheets of drawing(s).

__ An assignment of the invention to Nortel Networks Corporation (includes Recordation Form Cover Sheet).

__ A certified copy of a __ application.

__ Information Disclosure Statement, PTO 1449 and copies of references.

The filing fee has been calculated as shown below:

For	Number Filed	Number Extra	Rate	Fee
Basic Fee				$710.00
Total Claims	20 - 20		x 18 =	$ .00
Indep. Claims	3 - 3		x 80 =	$ .00
MULTIPLE DEPENDENT CLAIM PRESENTED			x 260 =	$
			TOTAL	$710.00

X Enclosed please find a check in the amount of $710.00.

X The Commissioner is hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account 06-0580. A duplicate copy of this sheet is enclosed.

X Any additional filing fees required under 37 CFR §1.16.

X Any patent application processing fees under 37 CFR §1.17.

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Beth Costner Beth Costner

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MOBILE IP EXTENSIONS RATIONALIZATION (MIER)

RELATED APPLICATIONS

This application is a continuation-in-part of commonly assigned, copending United States patent application 60/159,407 filed October 14, 1999. The content of the above-identified application is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Technical Field:

The present invention generally relates to communications with mobile nodes in Internet Protocol (IP) networks and in particular to mobile IP control messages employed to configure communications for mobile nodes. Still more particularly, the present invention relates to the structure of extensions employed with mobile IP control messages.

2. Description of the Related Art:

Explosive growth in the use of wireless or "mobile" communications devices to access Internet Protocol (IP) networks such as the Internet has lead to the development of IP mobility support, protocol enhancements which allow transparent routing of IP datagrams to mobile nodes within the Internet. These protocol enhancements support changes in the point of attachment for a mobile node from one network or subnetwork to another utilizing a home agent, a router on the mobile node's home network which maintains current location information for the mobile node and which tunnels datagrams for delivery to the mobile node when the mobile node is away from the home network, and a foreign agent, a router on a mobile node's "visited" network which provides routing services to the mobile node.

IP mobility support allows the mobile nodes, which each have a fixed "home" IP address corresponding to their home network(s), to register a "care-of" address

with a foreign agent, where the care-of address is the termination point of a tunnel toward the mobile node for datagrams forwarded to the mobile node while it is away from home. Registration of the care-of address is achieved through a registration request and a registration reply, the general structures of which are illustrated in **Figures 3A** and **3B**, respectively. Both the registration request and the registration reply include a fixed portion **302a** and **302b** followed by one or more extensions **304a** and **304b**.

The extensions **304a** and **304b** are part of a general extension mechanism employed by mobile IP to allow optional information to be carried by mobile IP control messages. In addition to registration requests and registration replys, agent discovery control messages, such as router advertisement and router solicitation messages defined for ICMP router discovery and employed by mobile IP for agent discovery, may also include extensions. Extensions allow variable amounts of information to be carried within each datagram. Each extension is encoded in the type-length-value format illustrated in **Figure 3C**, in which:

Type	Indicates the particular type of extension.
Length	Indicates the length (in bytes) of the data field within the corresponding extension, NOT including the Type and Length bytes. The Length field is utilized to skip the Data field in searching for the next extension.
Data	The particular data associated with the corresponding extension. This field may be zero or more bytes in length. The format and length of the Data field is determined by the Type and Length fields.

The Type field in the mobile IP extension structure can support up to 255 uniquely identifiable extensions. Several types are currently defined for mobile IP control messages:

32	Mobile-Home Authentication
33	Mobile-Foreign Authentication
34	Foreign-Home Authentication

In addition, mobile IP defines the following types for extensions appearing within

ICMP Router Discovery messages:

0	One-byte Padding (encoded with no Length or Data field)
16	Mobility Agent Advertisement
19	Prefix-Lengths

As large scale mobile IP deployment becomes imminent, there are many proposals for new extensions for Mobile IP, creating a strong possibility that the available type space will be exhausted and generating a real need to conserve the type field within the extensions structure.

It would be desirable, therefore, to provide a new extensions structure for mobile IP control messages which would make the extensions truly extensible and secure.

SUMMARY OF THE INVENTION

A new extensions structure for mobile IP control message extensions is employed to conserve the type field. Certain types of extensions, such as network access identifiers, are initially aggregated and sub-types are employed to identify the precise content of the extension (e.g., mobile node network access identifier, home agent network access identifier, foreign agent network access identifier, etc.). Long and short formats for the new extension structure are defined, with the long format applicable to nonskippable extensions carrying more than 256 bytes and the short format backwards compatible with currently defined skippable extensions with less than 256 bytes of data. This will greatly reduce usage of the type field.

All objects, features, and advantages of the present invention will become apparent in the following detailed written description.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself however, as well as a preferred mode of use, further objects and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

Figure 1 depicts a diagram of a communications system in which a preferred embodiment of the present invention is implemented;

Figures 2A-2B are block diagrams of a mobile IP extensions format in accordance with a preferred embodiment of the present invention; and

Figures 3A-3C are diagrams of mobile IP control messages and the existing mobile IP extension format.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference now to the figures and in particular with reference to **Figure 1**, a high level diagram of a communications system in which a preferred embodiment of the present invention is implemented is depicted. Communications system **102** includes a wireless communications device or mobile node **104**, which is depicted as a wireless telephone in the exemplary embodiment but which may be any wireless device employing IP data communications, such as a laptop or personal digital assistant (PDA). Wireless communications infrastructure **106** (including base stations, routers, and the like) enable mobile node **104** to communicate with an attachment point **108**, which in the exemplary embodiment is a mobile switching center (MSC) and IP router. Mobile node **104** need not be a wireless communications device as depicted, but may instead be a device which employs a wired connection capable of attachment to the Internet at different locations, within different networks and subnetworks.

Communications system **102** also includes a foreign agent (FA) **110**, a router which provides routing services to the mobile node **104**. Although depicted as separate from attachment point **108** for mobile node **104**, foreign agent **110** may actually be integrated with the attachment point **108**. Foreign agent **110** is connected to the Internet backbone **112**, to which is also connected the home agent **114** for mobile node **104**, which is a router within the home network **116** for mobile node **104**, and host system **118**, which may be any server or peer host system with which mobile node **104** is attempting to communicate.

In operation, mobility agents (including foreign agent **110** and home agent **114**) advertise their presence via agent advertisement messages (which may optionally be solicited by any locally attached mobile node through an agent solicitation message). Mobile node **104** received the agent advertisement messages and determines whether it is attached to its own home network or to a foreign network. When mobile node **104** detects that it is attached to a foreign network, it obtains a care-of address (e.g., from the agent advertisements of foreign agent **110**). Mobile

node **104** then registers the care-of address with its home agent **114** utilizing the registration request and registration reply. Subsequently, datagrams sent to the home IP address of mobile node **104** from host system **118** are intercepted by home agent **114** and tunneled to the care-of address, received at the tunnel endpoint (either foreign agent **110** or mobile node **104** itself) and finally delivered to mobile node **104**. Datagrams sent by mobile node **104** to host system **118** are generally delivered using standard IP routing mechanisms.

Mobile IP control messages employed to establish the connection of mobile node **104** to foreign agent **110**, including any agent advertisements, the registration request, and the registration reply, all employed the improved mobile IP extensions format in accordance with the present invention, as described in further detail below.

Referring to **Figures 2A-2B**, block diagrams of a mobile IP extensions format in accordance with a preferred embodiment of the present invention are illustrated. **Figure 2A** illustrates the long extension format in accordance with the present invention, which is applicable for non-skippable extensions which carry information or more than 256 bytes and should be applicable to any future standardization which addresses non-skippable extensions accommodating up to 64 KBytes of data. The general structure of the long extension format includes the following fields:

Type	Indicates the type, which describes a collection of extensions having a common data type.
Sub-Type	Includes a unique number assigned to each member in the aggregated extension type. Sub-Type values between 200 and 255 should be reserved for future use and standardization.
Length	Indicates the length (in bytes) of the data field within the corresponding extension; does NOT include the type, length and sub-type bytes.
Data	The particular data associated with the corresponding extension, which may be represented in many ways.

Figure 2B illustrates the short extension format in accordance with the

present invention, which is backward compatible with the skippable extensions currently defined for mobile IP control messages and is applicable for extensions which do not require more than 256 bytes of data. The general structure of the short extension format consists of the following fields:

Type	Indicates the type, which describes a collection of extensions having a common data type.
Sub-Type	Includes a unique number assigned to each member in the aggregated extension type. Sub-Type values between 200 and 255 should be reserved for future use and standardization.
Length	Indicates the length (in bytes) of the data field within the corresponding extension; does NOT include the type, length and sub-type bytes.
Data	The particular data associated with the corresponding extension, which may be represented in many ways.

In the present invention, the type field of the extensions format identifies the format of the remainder of the extension (i.e., whether the length or sub-type field follows the type field), as well as whether the extension is skippable or nonskippable. Common types of extensions, such as network access identifier (NAI) extensions, are aggregated under a single type identifier, with sub-type identifiers distinguishing different content-types for the extension (e.g., mobile node or user network access identifier, home agent network access identifier, etc.). This will greatly reduce the usage of the extension type field.

Figures 2C through **2E** illustrate specific mobile IP extensions employing the extensions formats of the present invention. **Figures 2C** and **2D** illustrate extensions utilizing the nonskippable long format, while **Figure 2E** illustrates an extension utilizing the skippable short format.

Figure 2C illustrates a generic authentication extension, which consists of the following fields:

Type	Contains the authentication extension type identifier.

Sub-Type	Describes the type of entity which owns the corresponding authentication extension. The following identifiers are defined: 1 MN-AAA (mobile node authentication, authorization and accounting) extension.
Length	The length of the Authenticator field.
SPI	Security Parameters Index, a 32 bit number indexing and uniquely identifying a security association (SA) (the shared secret keys, security attributes and policy defined for protection of traffic between any two nodes in a network) within a database.
Authenticator	The variable length authenticator field contains a random value of at least 128 bits.

Figure 2D illustrates a general session key extension, which defines a general purpose security association extension carrying information necessary to establish security association between different entities within the mobile IP model (e.g., mobile node-foreign agent, foreign agent-home agent, mobile node-home agent) and consists of the following fields:

Type	Contains the generic AA key extension type identifier.
Sub-Type	Defines the type of entity which owns the key address: 0 MN-HA (mobile node-home agent) key 1 MN-FA (mobile node-foreign agent) key 2 FA-HA (foreign agent-home agent) key
Length	The length of the SA-INFO field.
SPI1	A 32 bit opaque value indicating the SPI which the mobile node must use to determine which algorithm to employ for recovering the security information.
SPI2	A 32 bit opaque value which the mobile node MUST use to index all the necessary information recovered from the foreign agent security information after decoding.
Security Info	The necessary information (including the key, algorithm, etc.)

required by the mobile node to create a mobility security association between itself and another entity such as a home agent or foreign agent.

Figure 2E illustrates a general network access identifier (NAI) extension for different types of entities such as a mobile node, home agent, foreign agent, etc., and which consists of the following fields:

Type	Contains the NAI aggregate extension type identifier.
Sub-Type	Defines the type of entity which owns the key address:
	0 MN-HA (mobile node-home agent) key
	1 MN-FA (mobile node-foreign agent) key
	2 FA-HA (foreign agent-home agent) key
Length	The length of the NAI-INFO field.
NAI-INFO	Contains the NAI in a string format.

By aggregating extension types, space within the type field of the mobile IP extensions structure is conserved. Extensions are preferably aggregated based on common data formats (e.g., network access identifiers, security associations, etc.). Sub-types are then employed to precisely identify extension content.

It is important to note that while the present invention has been described in the context of a fully functional data processing system and/or network, those skilled in the art will appreciate that the mechanism of the present invention is capable of being distributed in the form of a computer usable medium of instructions in a variety of forms, and that the present invention applies equally regardless of the particular type of signal bearing medium used to actually carry out the distribution. Examples of computer usable mediums include: nonvolatile, hard-coded type mediums such as read only memories (ROMs) or erasable, electrically programmable read only memories (EEPROMs), recordable type mediums such as floppy disks, hard disk drives and CD-ROMs, and transmission type mediums such as digital and analog communication links.

While the invention has been particularly shown and described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.

CLAIMS

What is claimed is:

1. A mobile Internet Protocol extension, comprising:

a type field containing a type value identifying a collection of extensions having a common data type;

a sub-type field containing a unique number assigned to a member of the collection of extensions identified by the type value within the type field; and

a data field containing the data associated with the extension.

2. The mobile Internet Protocol extension of claim 1, further comprising:

a length field indicating a length in bytes of the data field within the extension.

3. The mobile Internet Protocol extension of claim 1, wherein the sub-type field follows the type field within a short format for the extension.

4. The mobile Internet Protocol extension of claim 1, wherein the sub-type field is separated from the type field by a length field within a long format for the extension.

5. The mobile Internet Protocol extension of claim 1, wherein the type field is a first field within the extension, followed by the sub-type field and then a length field within a long format for the extension and followed by the length field and then the sub-type field within a short format for the extension.

6. The mobile Internet Protocol extension of claim 1, wherein the type field contains a type value identifying a group of authentication extensions and the data field contains a security parameter index and an authenticator.

7. The mobile Internet Protocol extension of claim 1, wherein the type field contains a type value identifying a group of key extensions and the data field contains a first security parameter index, a second security parameter index, and security information

required to create a security association.

8. The mobile Internet Protocol extension of claim 1, wherein the type field contains a type value identifying a group of network access identifiers and the data field contains a network access identifier.

9. A method of extending control messages within a mobile Internet Protocol network, comprising:

storing a type value identifying a collection of extensions having a common data type within a type field for a message extension;

storing a unique number assigned to a member of the collection of extensions identified by the type value within the type field within a sub-type field for the message extension; and

storing the data associated with the extension within a data field for the message extension.

10. The method of claim 9, further comprising:

storing a length in bytes of the data field within a length field for the message extension.

11. The method of claim 9, further comprising:

placing the sub-type field after the type field within a short format for the message extension.

12. The method of claim 9, further comprising:

placing a length field between the sub-type field and the type field within a long format for the extension.

13. The method of claim 9, further comprising:

placing the type field first within the extension, followed by the sub-type field and then a length field within a long format for the extension and followed by the length field and then the sub-type field within a short format for the extension.

14. The method of claim 9, wherein the step of storing a type value identifying a collection of extensions having a common data type within a type field for a message extension further comprises:

storing a type value identifying a group of authentication extensions within the type field, wherein the data field contains a security parameter index and an authenticator.

15. The method of claim 9, wherein the step of storing a type value identifying a collection of extensions having a common data type within a type field for a message extension further comprises:

storing a type value identifying a group of key extensions within the type field, wherein the data field contains a first security parameter index, a second security parameter index, and security information required to create a security association.

16. The method of claim 9, wherein the step of storing a type value identifying a collection of extensions having a common data type within a type field for a message extension further comprises:

storing a type value identifying a group of network access identifiers within the type field, wherein the data field contains a network access identifier.

17. An Internet Protocol network supporting mobile connections, comprising:

a mobile communications device;

a home agent within a home network for the mobile communications device;

a foreign agent within a network to which the mobile communications device is connected, wherein the home agent and the foreign agent communicate utilizing control messages which may be extended by an extension including:

a type field identifying a collection of extensions having a common data type,

a sub-type field identifying a member of the collection of extensions identified by the type field, and

a data field containing the data associated with the extension.

18. The network of claim 17, wherein the sub-type field is placed in a first location within the extension for a short format of the extension and in a second location within the extension for a long format of the extension.

19. The network of claim 17, wherein the extension includes a length field specifying a length of the data field in bytes.

20. The network of claim 17, wherein the type field identifies a group of extensions selected from the group including an authentication extension, a key extension, and a network access identifier extension.

MOBILE IP EXTENSIONS RATIONALIZATION (MIER)

ABSTRACT OF THE DISCLOSURE

A new extensions structure for mobile IP control message extensions is employed to conserve the type field. Certain types of extensions, such as network access identifiers, are initially aggregated and sub-types are employed to identify the precise content of the extension (e.g., mobile node network access identifier, home agent network access identifier, foreign agent network access identifier, etc.). Long and short formats for the new extension structure are defined, with the long format applicable to nonskippable extensions carrying more than 256 bytes and the short format backwards compatible with currently defined skippable extensions with less than 256 bytes of data. This will greatly reduce usage of the type field.

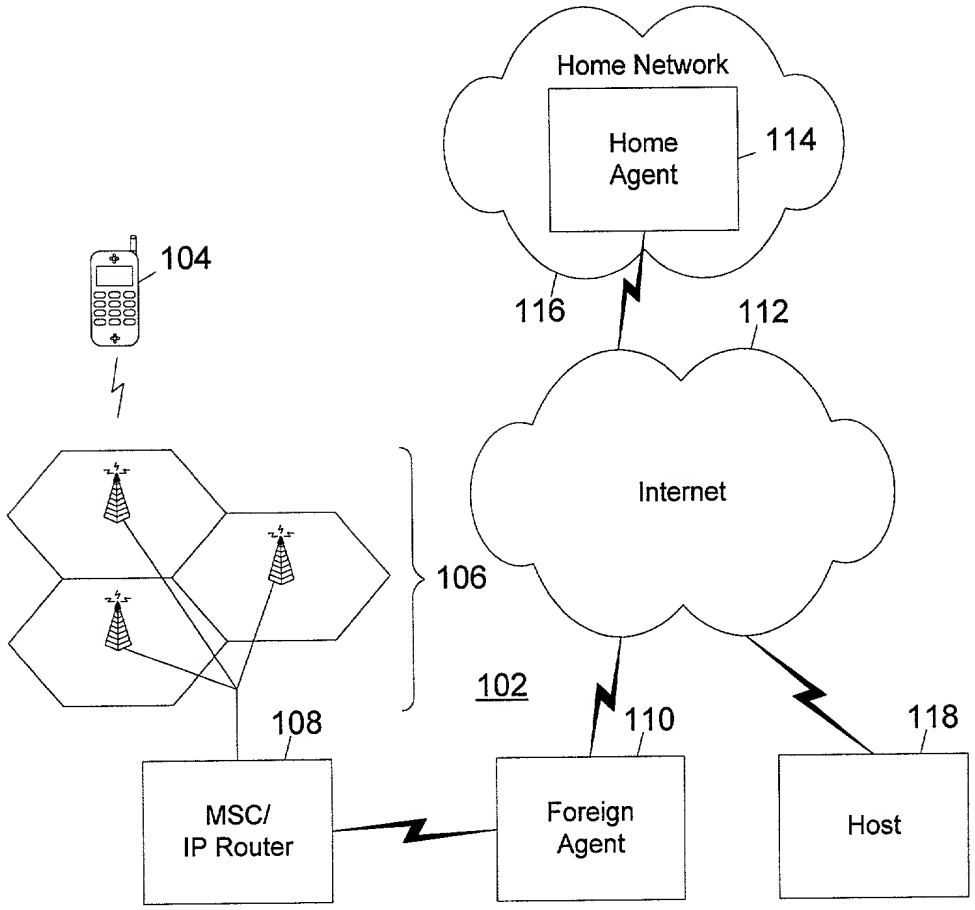
Home Network
Home Agent
114
104
116
112
Internet
106
102
108
110
118
MSC/ IP Router
Foreign Agent
Host

Figure 1

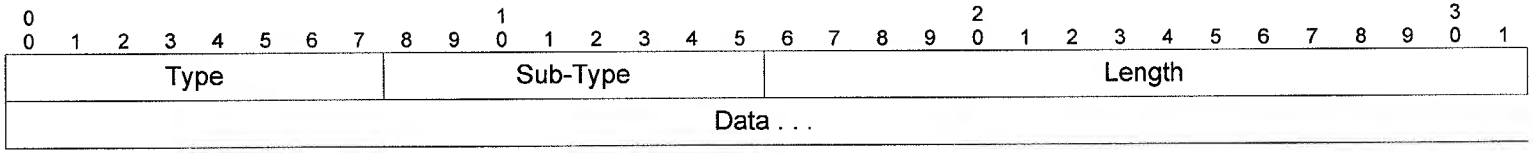

Figure 2A

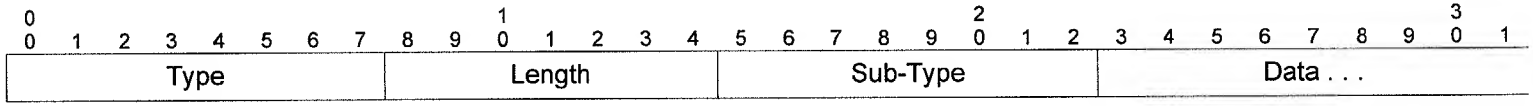

Figure 2B

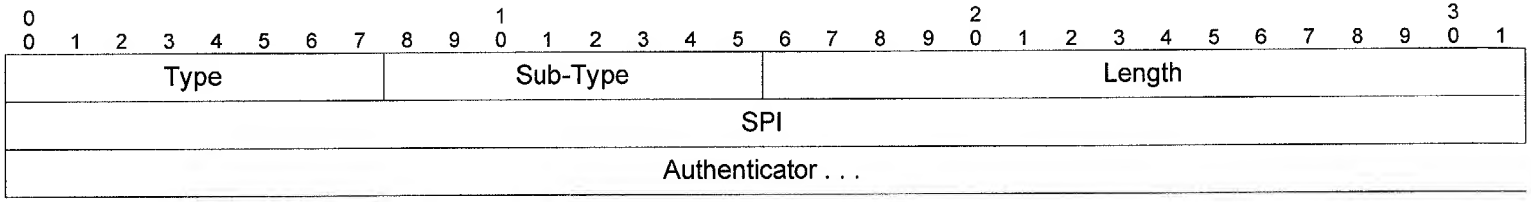

Figure 2C

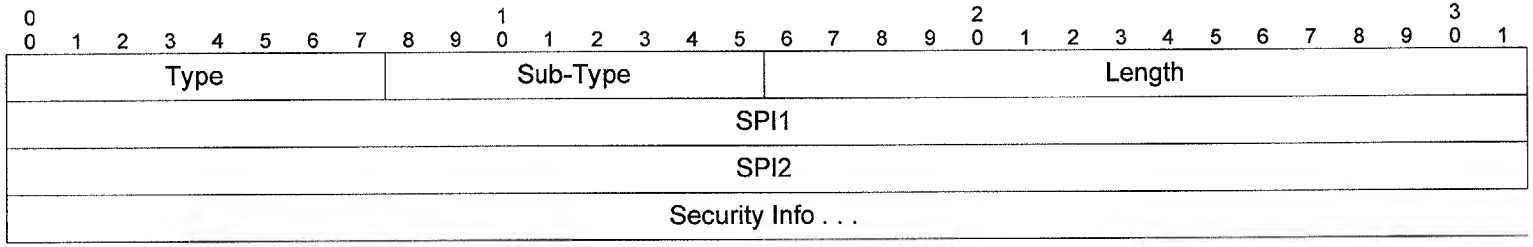

Figure 2D

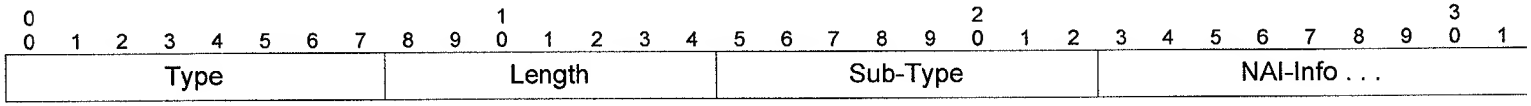

Figure 2E

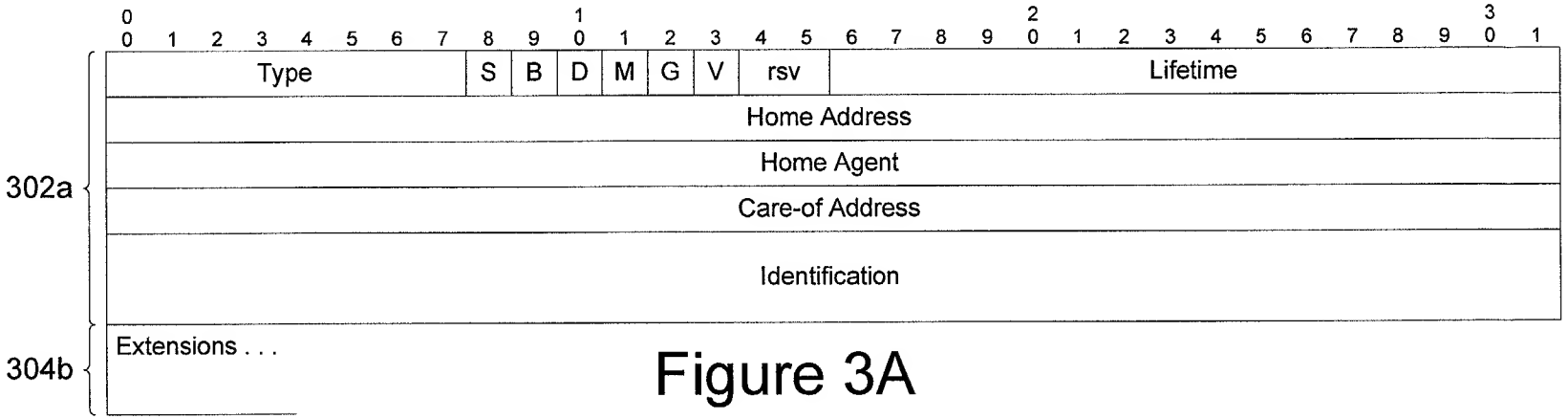

Figure 3A
(Prior Art)

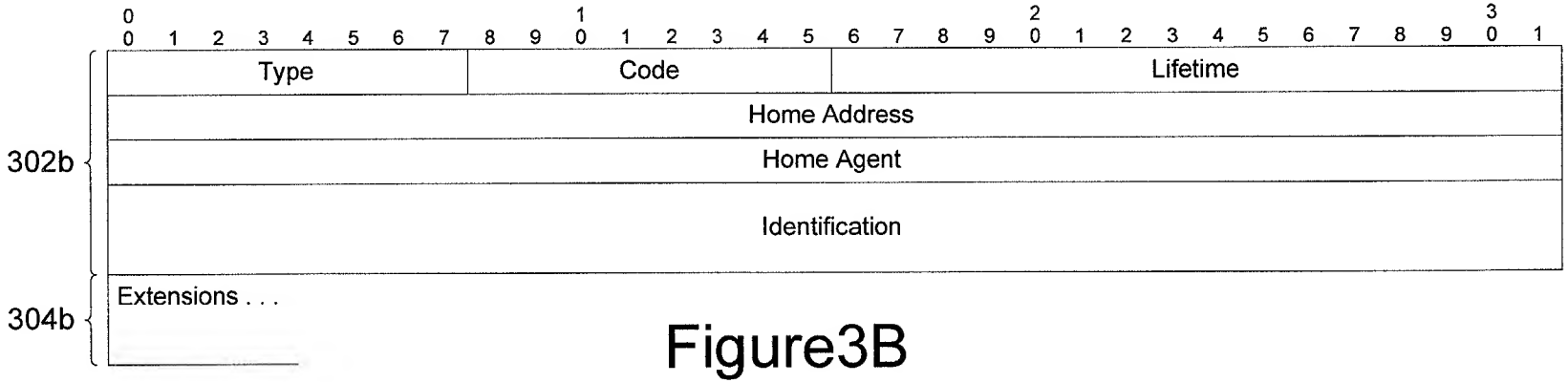

Figure3B
(Prior Art)

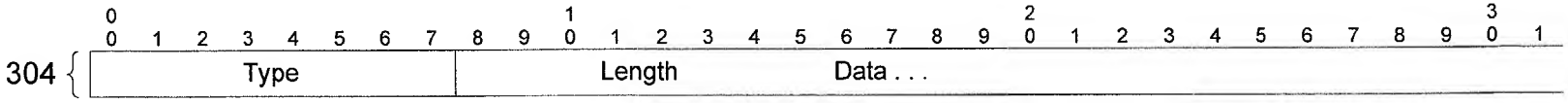

Figure 3C
(Prior Art)

DOCKET NUMBER: **RR11462**

DECLARATION AND POWER OF ATTORNEY FOR

PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled as set forth below, which is described in the specification of which: (check one)

X is attached hereto.

__ was filed on _____
as Application Serial No. _____
and was amended on _____(if applicable)

MOBILE IP EXTENSIONS RATIONALIZATION (MIER)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information material to the patentability of this application as defined in Title 37, Code

of Federal Regulations, §1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

60/159,407	October 14, 1999	Pending
(Application Serial #)	(Filing Date)	(Status)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorneys and/or agents to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

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